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## Description

The present invention relates to a data communications system, especially but not solely to a mainsborne signalling system which makes use of the electrical supply wiring.

5 A typical system, for utility telemetry, such as detailed in US Patent number 3,967,264, has a central controller located at a distribution substation and a large number of home units each sited at the premises of a consumer adjacent to the electricity meter. Communication between the central controller and the home units is achieved by sending spread spectrum signals via the mains electricity circuit wiring. Clearly many sources of noise and attenuation (inter alia normal domestic equipment) are connected intermittently  
10 and randomly into the system, thereby producing unpredictable degrees of line attenuation and of interference with the system signals at any given time. Accordingly the range of a signal emitted from the central control (or from a home unit) tends to vary significantly, dependent on the time of day and on the season of the year.

An object of the present invention is to provide a data communications system which is not subject to  
15 the disadvantages associated with the variability of signal range.

A system for power line communications comprising: a main control unit; a plurality of stations capable of receiving, generating and generating and transmitting signals, the stations being disposed along a common transmission line such that the signals may be directly transmitted between the main control unit and any intended destination station;

20 signal-repeater means in selected one or more of the plurality of stations, the system arranged to selectively effect use of the signal-repeater means in selected one or more of the plurality of stations in sending a signal along the common transmission line, the system characterized by further comprising; determining means for determining that a signal has not reached its intended destination station;

modifying means for modifying the signal determined as not reaching its intended destination in order  
25 to address the said signal to at least one intermediate station incorporating signal-repeater means for subsequent routing to its intended destination station;

directing means for directing the signal to the at least one intermediate station corresponding to the modified address for subsequent routing to its intended destination station; and

30 monitoring means for monitoring the launch of the signal from the at least one intermediate station towards its intended destination station(s).

Thus, for example, when a system signal is unable to reach its destination station(s), it can be routed via one or more intermediate stations which act, in this circumstance, as a repeater.

Preferably the system utilizes a signal which includes a section identifying the target station(s) which is or are the intended destination of the signal, and a section identifying any intermediate station which is to  
35 act as a repeater in a re-routing operation.

Preferably a station has means to process a received signal to locate and inspect any target identity and/or repeater identity contained within the received signal; the station may also have means to compare any identity of a received signal with that of the station identity and means to effect appropriate action.

Preferably a station has a target identity which is for use when that station is the intended destination of  
40 a signal, and a repeater identity (different to the target identity) which is for use when that station is to operate on the signal as a repeater.

In order that the invention may more readily be understood, a description is now given, by way of example only, reference being made to the accompanying drawings, in which:

45 Figure 1 is a schematic diagram of part of a data communications system embodying the present invention; and

Figure 2 is a schematic diagram of the format of a signal used in the system of Figure 1.

The mainsborne signalling network 1 illustrated in Figure 1 has a main control unit 2 located at a distribution substation; this control unit 2 can communicate with any of a number of home units 3 by means of signals sent along the electrical mains wiring 4. Each home unit 3 is associated with a separate  
50 household and is located at the respective electricity meter such that it can provide information on the meter reading (and optionally on the condition of the meter) and other information whenever polled by the control unit 2. In Figure 1, the home units are labelled "HU 1", "HU 2" and so on, in order to clarify distinction between individual units; some of the home units 3 (namely HU 2, HU 4 and HU 6) have signal-repeater facilities, whose use will be described in greater detail below. Each of the control unit 2 and of the home  
55 units 3 has an address identity unique in the network 1; for simplicity, the address identity for control unit 2 is referred to as A, that for HU 1 as B, that for HU 2 as C and so on.

Consider the situation in which control unit 2 requires to determine the electricity meter reading for the property at which HU 7 is located. Accordingly control unit 2 applies, to the mains wiring 4, a signal R

targeted at HU7 and instructing it to send a return signal indicating the respective meter reading. Thereafter, control unit 2 monitors the mains wiring 4 for any acknowledgement signals or return signals from HU 7. If the line attenuation or interference on mains wiring circuit is substantial, it may reduce the range of any signal output from control unit 2 to such an extent that it would not reach HU 7. Thus, if after a predetermined time the control unit has not detected any such acknowledgement or return signal, it re-routes the signal R to an intermediate home unit which has a repeater facility, for example HU 6. After sending out the re-routed signal R, it monitors the wiring 4 for any acknowledgement signal from HU6 or for launch of the signal from HU 6 towards HU 7; if, after a predetermined time, control unit 2 has not detected any such signal from HU 6, it re-routes the signal R to a closer home unit with a signal-repeater facility, for example HU 4. If the signal R reaches HU 4, then the latter cleans up and amplifies the signal R before launching it again onto mains wiring 4 towards HU 7; HU 4 attempts to send the signal directly to HU 7, but if this fails it re-routes it via an intermediate home unit with a signal-repeater facility, i.e. HU 6. Alternatively, HU 4 notes the range of the signal R already achieved (i.e. in this case from central control unit 2 to HU 4) and plans the continued path to HU 7 accordingly.

A signal to be sent on the network 1 has the format as illustrated in Figure 2. The signal has three sections. One section defines the home unit which is to be used as an intermediate in a re-routing operation, this section consisting of two bytes for the address of the respective home unit acting as the intermediate, one byte indicating the identity of the central control unit (necessary when a number of networks, each with their own central control, are connected together), and one byte for control information. Another section defines the home unit(s) which is or are the intended destination for the signal, this section consisting of two bytes for the address of the target home unit(s), one byte for the identity of the central control unit and one byte for control information. The remaining section consists of n bytes of data information to be supplied to the target home unit(s) to instruct whatever operation is appropriate.

Returning to the situation of control unit 2 needing to communicate with HU 7, the following table lists the necessary stages when the line attenuation and/or interference is such that the range of the signal output by control unit 2 is less than the distance between three home units, assuming (for the purpose of this simplified example) that they are all equi-spaced.

STAGE	TRANSMITTING UNIT	SIGNAL SENT OUT (BYTE NOS)								RESPONSE
		0/1	2	3	4/5	6	7	8	X	
1	Control Unit 1	-	-	-	H	A	W	Z		None
2	Control Unit 1	G	A	Y	H	A	W	Z		None
3	Control Unit 1	E	A	Y	H	A	W	Z		None
4	Control Unit 1	C	A	Y	H	A	W	Z		Received
5	Home Unit 2	-	-	-	H	C	W	Z		None
6	Home Unit 2	G	C	Y	H	C	W	Z		None
7	Home Unit 2	E	C	Y	H	C	W	Z		Received
8	Home Unit 4	-	-	-	H	E	W	Z		None
9	Home Unit 4	G	E	Y	H	E	W	Z		Received
10	Home Unit 6	-	-	-	H	G	W	Z		Received

In this table, Y represents the control information for any home unit acting as an intermediate, W represents the control information for the target home unit HU 7, and Z represents the data information for

the target home unit HU 7. Thus at the start of the transmission operation, main control unit 2 applies to the wiring 4 a signal R which has byte numbers 1 to 4 blank, byte numbers 4 and 5 containing identity H, byte number 6 containing identity A, byte number 7 containing W and byte numbers 8 to X containing Z. Once control unit 2 has applied this signal to wiring 4, the control unit monitors wiring 4 for any response from HU 7, but none is forthcoming. Thereafter it proceeds to the second stage indicated in the table, and so on.

In one form of home unit for use in the network 1, each home unit has the ability to function either in normal mode or in repeater mode. The repeater capability of the home unit is achieved by the provision of programmed procedures held in memory devices; operation of these procedures is implemented when the home unit detects a repeater command in any received signal. The home unit uses a single set of access protocols both for its normal mode and for its repeater mode. The home unit consists of an interface connected to a control bus, which also functions as a system address bus and a system data bus. The control bus is connected to a processing block which incorporates a central processing unit, a clock and ROM and RAM storage which includes the normal mode procedures and the repeater mode procedure. The control bus is also connected to a power supply unit and to control units with interfaces to the user.

### Claims

#### 1. A system for power line communications comprising:

a main control unit (2); a plurality of stations (3) capable of receiving, generating and transmitting signals, the stations (3) being disposed along a common transmission line (4) such that the signals may be directly transmitted between the main control unit (2) and any intended destination station (3); signal-repeater means in selected one or more of the plurality of stations (3), the system arranged to selectively effect use of the signal-repeater means in selected one or more of the plurality of stations (3) in sending a signal along the common transmission line (4), the system characterized by further comprising;

determining means for determining that a signal has not reached its intended destination station (3);

modifying means for modifying the signal determined as not reaching its intended destination in order to address the said signal to at least one intermediate station incorporating signal-repeater means for subsequent routing to its intended destination station (3);

directing means for directing the signal to the at least one intermediate station corresponding to the modified address for subsequent routing to its intended destination station (3); and

monitoring means for monitoring the launch of the signal from the at least one intermediate station towards its intended destination station(s)(3).

#### 2. A system according to claim 1 wherein the stations (3) include processing means for processing a received signal to locate and inspect any target identity and/or repeater identity contained within the received signal.

#### 3. A system according to either claim 1 or claim 2 wherein a station(3) having a target identity which is for use when that station is the intended destination of a signal, and a repeater identity (different to the target identity) which is for use when that station is to operate on the signal as a repeater.

#### 4. A system according to any one of the preceding claims wherein a station (3) includes: processing means for processing a received signal to locate and inspect any target identity and/or repeater identity contained within the received signal; and further processing means for determining if a received signal is to be repeated, thereby to modify the received signal and transmit the modified signal to subsequent stations (3).

### Revendications

#### 1. Un système de communication par lignes de transmission de courant, comprenant :

- une unité principale de commande (2) ; un ensemble de stations (3) capables de recevoir, engendrer et émettre des signaux, les stations (3) étant disposées le long d'une ligne de transmission commune (4) de telle sorte que les signaux puissent être directement transmis entre l'unité principale de commande (2) et une station destinatrice envisagée (3) ; des moyens répéteurs de signaux dans une ou plusieurs stations sélectionnées dans l'ensemble de stations (3), le système étant agencé pour utiliser sélectivement les moyens répéteurs de signaux dans

une ou plusieurs stations sélectionnées dudit ensemble (3) en émettant un signal dans la ligne de transmission commune (4), le système étant caractérisé en ce qu'il comprend en outre :

- un moyen de détermination pour déterminer que le signal n'a pas atteint sa station destinatrice envisagée (3) ;
- 5       - un moyen de modification pour modifier le signal déterminé comme n'ayant pas atteint sa destination envisagée de manière à adresser ledit signal vers au moins une station intermédiaire existante et comportant des moyens répéteurs de signaux en vue d'un acheminement ultérieur jusqu'à sa station destinatrice envisagée (3) ;
- un moyen de direction pour diriger le signal jusqu'à la station intermédiaire correspondant à l'adresse modifiée en vue d'un acheminement ultérieur jusqu'à sa station destinatrice envisagée (3) ; et
- 10       - un moyen de contrôle pour contrôler l'envoi du signal depuis ladite station intermédiaire vers la (les) station(s) destinatrice(s) (3).

15   2. Un système selon la revendication 1, dans lequel les stations (3) comprennent des moyens de traitement pour traiter un signal reçu afin de localiser et de contrôler une identité de cible et/ou une identité de répéteur contenue dans le signal reçu.

20   3. Un système selon la revendication 1 ou la revendication 2, dans lequel une station (3) comporte une identité de cible qui est utilisable lorsque cette station est la destination envisagée d'un signal, et une identité de répéteur (différente de l'identité de cible) qui est utilisable lorsque cette station doit opérer sur le signal comme un répéteur.

25   4. Un système selon l'une quelconque des revendications précédentes, dans lequel une station (3) comprend : des moyens de traitement pour traiter un signal reçu afin de localiser et de contrôler une identité de cible et/ou une identité de répéteur contenue dans le signal reçu ; et d'autres moyens de traitement pour déterminer si un signal reçu doit être répété, afin de modifier ainsi le signal reçu et de transmettre le signal modifié à des stations suivantes (3).

### 30   Patentansprüche

1. System für eine Netzleitungs-Nachrichtenverbindung, umfassend:

35       eine Hauptsteuereinheit (2), eine Vielzahl von Stationen (3), die Signale empfangen, erzeugen und aussenden können, wobei die Stationen (3) entlang einer gemeinsamen Übertragungsleitung (4) so angeordnet sind, daß die Signale direkt zwischen der Hauptsteuereinheit (2) und irgendeiner beabsichtigten Bestimmungsstation (3) übertragen werden können, wobei Signalwiederholungsmittel in einer oder mehreren ausgewählten Stationen (3) vorgesehen sind und das System so ausgebildet ist, daß wahlweise von den Signalwiederholungsmitteln in einer oder mehreren ausgewählten Stationen (3) bei der Sendung eines Signals entlang der gemeinsamen Übertragungsleitung Gebrauch gemacht wird, dadurch gekennzeichnet, daß das System ferner umfaßt:

40       Bestimmungsmittel zur Bestimmung, daß ein Signal nicht seine beabsichtigte Bestimmungsstation (3) erreicht hat,

45       Modifizierungsmittel zur Modifizierung des Signals, von dem festgestellt wurde, daß es seine beabsichtigte Bestimmung nicht erreicht hat, um das Signal zu wenigstens einer Zwischenstation zu adressieren, die Signalwiederholungsmittel für die nachfolgende Weiterleitung zu seiner beabsichtigten Bestimmungsstation (3) enthält;

50       Leitmittel zur Leitung des Signals zu wenigstens einer Zwischenstation entsprechend der modifizierten Adresse für die nachfolgende Weiterleitung zu seiner beabsichtigten Bestimmungsstation (3), und

Überwachungsmittel zur Überwachung des Starts des Signals von der wenigstens einen Zwischenstation zu seiner beabsichtigten Bestimmungsstation (3) bzw. seinen beabsichtigten Bestimmungsstationen.

55   2. System nach Anspruch 1, bei dem die Stationen (3) Verarbeitungsmittel für die Verarbeitung eines empfangenen Signals enthalten, um eine in dem empfangenen Signal enthaltene Zielidentität und/oder Wiederholungsidentität zu lokalisieren und zu inspizieren.

3. System nach Anspruch 1 oder 2, bei dem eine Station (3) eine Zielidentität hat, von der Gebrauch

gemacht wird, wenn diese Station die beabsichtigte Bestimmung eines Signals ist, sowie eine (von der Zielidentität unterschiedliche) Wiederholungsidentität, von der Gebrauch gemacht wird, wenn die Station für das Signal als Wiederholer arbeiten soll.

- 5 4. System nach einem der vorhergehenden Ansprüche, bei dem eine Station (3) enthält: Verarbeitungsmittel zur Verarbeitung eines empfangenen Signals, um eine in dem empfangenen Signal enthaltene Zielidentität und/oder Wiederholungsidentität zu lokalisieren und zu inspizieren, sowie weitere Verarbeitungsmittel, um zu bestimmen, ob ein empfangenes Signal wiederholt werden soll, und um dieses empfangene Signal zu modifizieren und das modifizierte Signal zu nachfolgenden Stationen zu übertragen.
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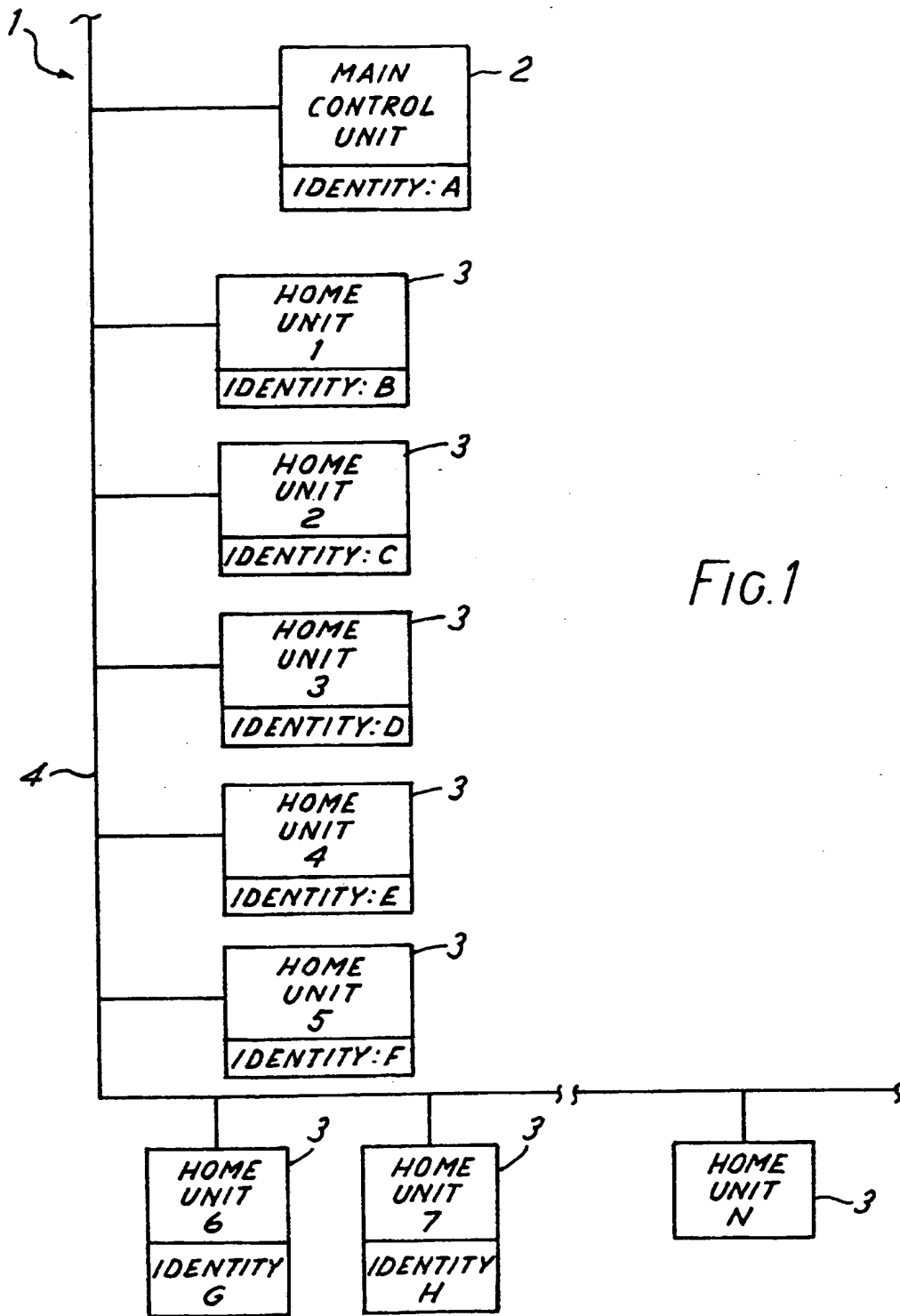


FIG.1

FIG. 2

